MASS OF THE EJECTED ENVELOPE OF LV VULPECULAE

D. Raikova
Department of astronomy, Bulgarian academy of sciences, Sofia, Bulgaria

LV Vulpeculae is a fast nova with a relatively smooth light curve (Raikova, 1981). On Fig. 1 the picture of the radial velocities, displayed during the outburst is shown. It is based on our measurements and the published ones (a more detailed paper will appear in C. R. Acad. Bulg. Sci.). The premaximum absorption line system (A) exhibits a rapidly decreasing velocity. It has been observed for the last time on April 17.52 (Hutchings, 1970) together with the diffuse enhanced system (B) of velocity -1260 km/s. Since the presence of the last system is an indication that the light maximum has passed, we can limit a 2^h40^m interval in which it had occured (on April 17.385 the brightness is still up). We assume that the light maximum has taken place at the middle - on April 17.45. On April 18 the diffuse enhanced line system, now of -1400 km/s, and the principal one (C) of -780 km/s exist. It is worth-while to emphasize that in LV Vul spectrum the diffuse enhanced system appeared b e f o r e the principal one.

The remarkable feature of the outburst is the great increase with

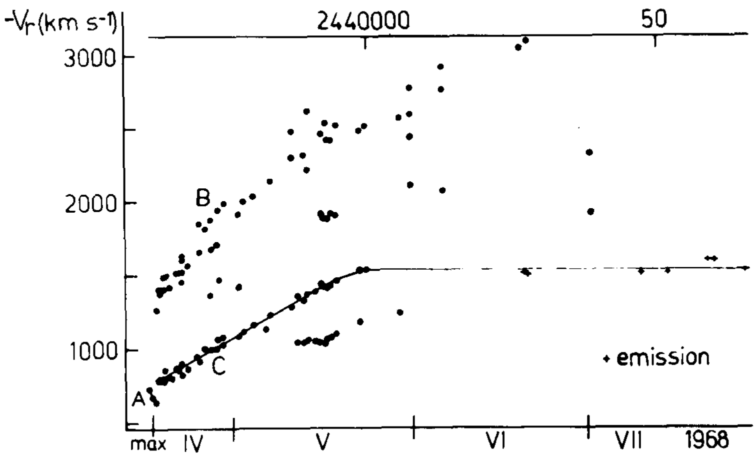

Fig. 1. Radial velocities and line systems in LV Vul spectrum

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time of the velocities, measured from both systems B and C. For the diffuse enhanced and later the orion systems it means an increase of the velocity of the optically thick wind after the maximum light. For the principal spectrum this is an indication of acceleration of the material, ejected at light maximum, when the mass loss rate $\dot{m}$ also reaches its maximum. This acceleration gives an opportunity to determine the envelope mass. It may be due both to radiation pressure and to momentum transfer from the high velocity overtaking gas. The radiation pressure must be ruled out because the observed acceleration 24.4 cm/s^2 would be reached for too low envelope mass even if all the radiation $L \sim 10^{38}$ erg/s was absorbed. In order to use the momentum conservation law we need an independent estimate either of mass or of mass loss rate $\dot{m}$ (and then of the corresponding time interval).

1. We have carried out a curve of growth analysis of the premaximum spectrum for April 17.08. From the ionization equilibrium of Fe and the main source of free electrons H at 7000 K we have obtained $n_e = n_{HII} = 1.05\times10^{12}$ cm^{-3}, $n_H = 5.8\times10^{12}$ cm^{-3}, $\rho = 9.7\times10^{-12}$ g/cm^3. At that time the effective photosphere radius $R_{ph} = 128\ R_\odot$ (Raikova, 1981) and $V_o = 670$ km/s. Assuming spherical symmetry of the outburst we have

$$\dot{m} = 4\pi R_{ph}^2 \rho V_o = 6.6\times10^{23}\ g/s.$$

The sharp rise of R_{ph} begins about a day before the light maximum and during this time mass $m_o = 5.7\times10^{28}$ g has been ejected.

2. On April 18 the lines of the premaximum spectrum had completely disappeared. In about 16^h (Δt) the wind velocity V_w has increased from 1260 to 1400 km/s and the wind has overtaken all the previously ejected material and accelerated it up to $V_1 = 780$ km/s. From the momentum conservation and using $\overline{V}_w = 1330$ km/s we have

$$\dot{m}\ \Delta t\ (\overline{V}_w - V_1) = m_o\ (V_1 - V_o)$$

and $\dot{m} = 2.0\times10^{23}$ g/s. The envelope mass now amounts to $m_1 = 6.9\times10^{28}$ g.

3. During 35 days the envelope material has been accelerated to terminal velocity $V_2 = 1520$ km/s. In that period $V_w(t)$ has increased from 1400 to 2500 km/s following a parabola law. From there $\overline{V}_w = 2100$ km/s,

$$m_w\ (\overline{V}_w - V_1) = m_1\ (V_2 - V_1),$$

and $m_w = 8.7\times10^{28}$ g. So the final mass of the envelope is 1.6×10^{29} g and the mean value of $\dot{m} \approx 3\times10^{22}$ g/s.

Evidently the envelopes of novae of the type of LV Vulpeculae are finally formed only after the orion stage.

R e f e r e n c e s

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